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SURVEY OF THE FLORA OF COAL MINE WASTE DUMPS — A CASE STUDY OF CHASNALA MINES, DHANBAD, BIHAR

B. Saha, C. Chakravorty, P. K. Mukherjee
Department of Botany, University of Calcutta, Calcutta
AND
S. C. Santra
Department of Ecological Studies, School of Environmental Sciences, University of Kalyani, Kalyani

ABSTRACT

The paper deals with the flora of Chasnala mine complex including various dump sites. The survey of flora deals with enumeration of species, their life forms and dispersal types. It is evident that the dumps can acquire flora and advent of the species is contributed by flora of adjacent areas. The wind dispersed species are rich and the herbaceous species predominate initially. Chemophytes and hemicryptophytes have advantage in the pioneering stage. Grasses and legumes also appeared in the early successional stages.

INTRODUCTION

Mining of coal by open cast method requires removal of huge quantity of overburden and dumping the mass in and around the mining faces for their future re-use in back-filling. These dumps during their occupation of land surfaces, sometimes for decades, create problems of dispersion of dusts by wind and erosion by water apart from hurting the aesthetics. Stabilisation of these dumps as also derivation of some economic benefit from their temporary occupation can be achieved by vegetational growth. Fortunately, they acquire some natural vegetation in course of time, though the dumps being a kind of anthropogenic ecotopes have limitations both physical and chemical for plant growth. However, for successful revegetation of these places, a knowledge of the acquired flora is a prerequisite for assesment of the limitations and required remedial measures as also for selection of suitable types of plants. With that prospect in mind, the present report deals with flora of the overburden dumps and adjoining areas of the Chasnala Mines, Dhanbad, Bihar.

MATERIALS AND METHODS

Study site : The survey was conducted at Chasnala coal mines, IISCO, Dhanbad (Bihar). It is the captive coal mine for the IISCO's Burnpur Works. It covers a total area of 144.00 hectares. It is bounded on the south by the river Damodar, on the north by the Dhanbad-Sindri Road, in the east by the Perennial Stream-Domohanni Jore and on the west by the railway line to Sudamdih (Map). At present mining is primarily done by open cast method. There are three

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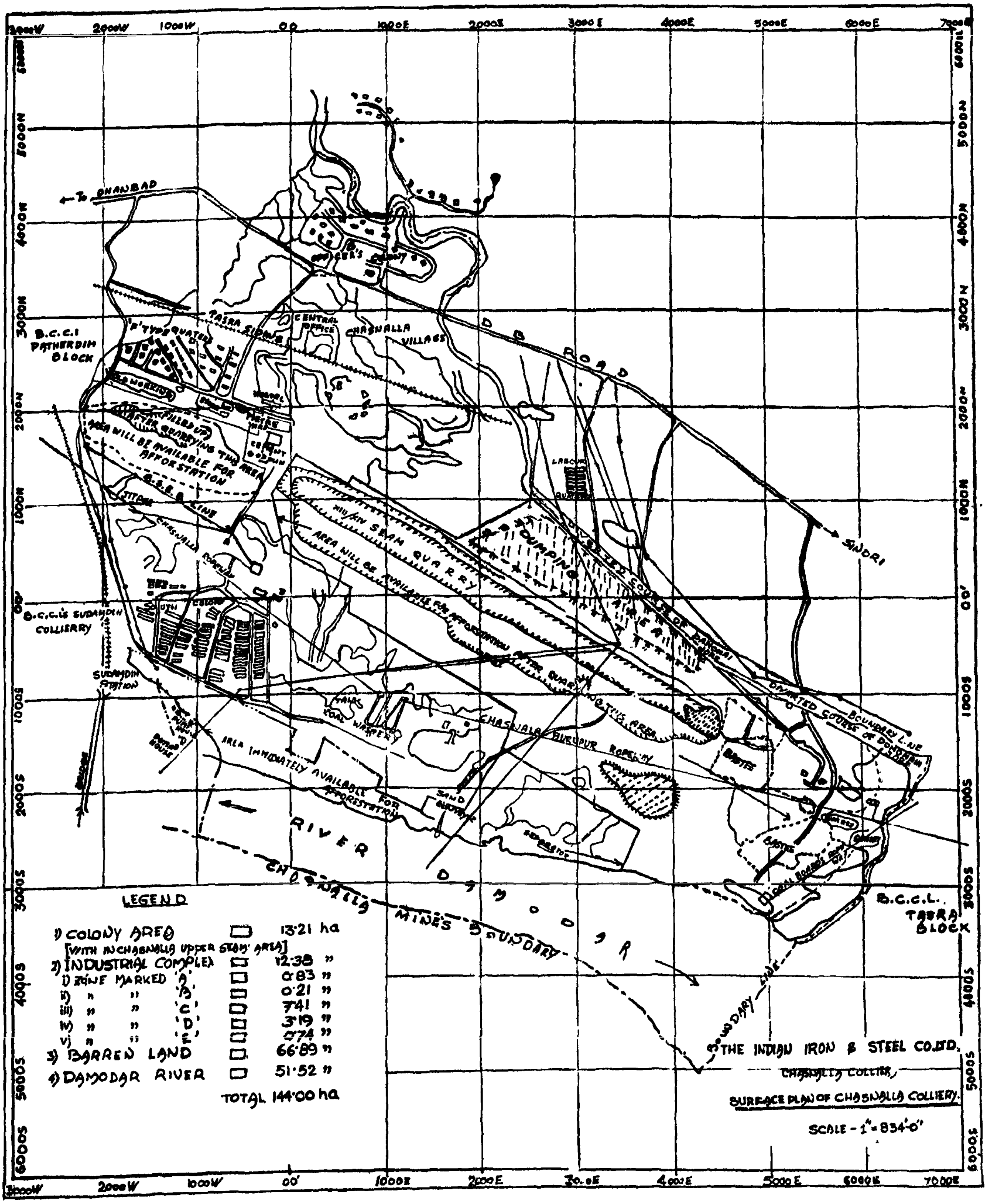

Map showing the waste dumps and adjoining areas of the Chasnala mines distinct kinds of overburden dumps within the mine complex :

(a) Alluvium dump on the northern side of the quarry and also adjoining river Damodar.

(b) Clay and sandstone mixture dump on the north-west corner of the quarry in the form of a flat topped hillock rising to about 10 m at places and sides sloping to an angle of about 60°. There are occasional filling of pure sands.

(c) Washery reject dump along the river embankment.

All these dumps are 10-12 years old and the colonisation and succession of plants have progressed during this time.

Survey of flora and collection of data on life form and phenology : The survey was conducted for three successive years 1985-88 at different seasons. Voucher specimens collected are preserved as herbarium specimens and identification of these were made by matching as well as by consulting relevant literatures. Field notes were taken as to their habit, time of flowering or fruiting, colour of flowers, physiological deformities, if any, and rarity or abundance. The life form classes (Raunkiaer, 1937) were also recorded in the field survey.

Study of plant community structures : The quantitative analyses of the plant community on the different study sites were done by quadrate and transect methods to determine the frequency, density and basal cover and importance value (Whittaker, 1970). However, the decision to use the quadrate or line transect was influenced by the nature of surface (topography) of the individual dump and/or sparseness of the vegetation.

By visual examination, comparison of yearwise floristic community study was carried out at each site to denote the pattern of successional changes in the herbage covering over dumps of various kinds,

Study of diaspore type : The determination of diaspore types of the different plants were done by field observations on the fruit types, their dehiscence, morphology of the seeds etc. The terminology follows Vander Pijl (1969) and Ridley (1930).

RESULTS

A detailed floristic account along with life form classes and dispersal types were mentioned in Table 1. It is clearly evident that three study sites viz., overburden dumps, alluvium dumps and washery reject dumps have different species composition and gradually the density of species varies with the maturity of the dumps. The natural vegetation cover is dominated by herbaceous forms, mainly annuals and grasses. On the whole, Chamaephytic plant forms (29.63%) dominate over other forms followed by hemicryptophytes (24.07%) and geophytes (18.25%). Though herbaceous species are a major constituent of the flora (77.7%), the redeeming feature is the appearance of a number of tree samplings and shrubs. The tree samplings of *Butea monosperma*, *Adina cordifolia*, *Alangium salvifolium*, *Azadirachta indica*, *Sterculia urens* were coming up as early successional forms after initial establishment of herbaceous forms along with shrubs like *Chromolaena odorata*, *Ziziphus mauritiana*, *Lantana camara* and *Calotropis procera* etc. in all the dumps. The advent of these taxa occurred as expected from the neighbouring areas.

Of the herbaceous species, some like *Evolvulus alsinoides*, *Scoparia dulcis*, *Polygala chinensis*, *Hybanthus ennaespermus* and *Oldenlandia corymbosa* together with some members of the Cyperaceae were found to be ruderals, inhabiting places of the dump, which are somewhat water-logged only during monsoon. Such plants give way to *Xanthium*, *Tephrosia* and *Cleome* etc. in the successional series. Grasses mostly are the invaders on compact slopes and spread

Table 1 : Floristic composition of, different dump sites at Chasnala Colliery Complex

Sl. No.	Name of the species	Family	Life form	Dispersal type	Habit	Distribution pattern		
						OB	WR	AD
1	2	3	4	5	6	7	8	9
1.	*Achyranthes aspera* L.	Amaranthaceae	Ch	Epz	H	+	+	+
2.	*Adina cordifolia* Hook. f.	Rubiaceae	Ph(M)	Pte	T	+	–	–
3.	*Ageratum conyzoides* L.	Asteraceae	Ch	Pog	H	+	+	–
4.	*Alangium salvifolium* (L.f.) Wang.	Cornaceae	Ph(m)	Enz	Ph(m)	+	–	–
5.	*Alternanthera sessilis* (L.) DC.	Amaranthaceae	Hc	Spo	H	–	+	–
6.	*Amaranthus spinosus* L.	Amaranthaceae	Hc	Spo	H	+	+	+
7.	*Ammannia baccifera* L.	Lythraceae	Hc	Spo	H	–	–	+
8.	*Anisomeles indica* (L.) O. Ktze.	Lamiaceae	Ph(m)	Spo	H	–	–	–
9.	*Argemone mexicana* L.	Papaveraceae	Th	Spo	H	+	+	+
10.	*Aristida adscencionis* L.	Poaceae	G	Ate	H	–	–	+
11.	*Azadirachta indica* Juss.	Meliaceae	Ph(M)	Enz	T	+	–	+
12.	*Blumea lacera* (Burm. f.) DC.	Asteraceae	Ch	Pog	H	–	+	+
13.	*Boerhavia diffusa* L.	Nyctaginaceae	Hc	Epz	H	+	+	+
14.	*Butea monosperma* (Lamk.) Taub.	Fabaceae	Ph(M)	Bal	T	+	+	+
15.	*Calotropis procera* Br.	Asclepiadaceae	Ph(m)	Pog	S	+	+	+
16.	*Centella asiatica* (L.) Urb.	Apiaceae	Hc	Hyd	H	–	–	+
17.	*Chloris barbata* Sw.	Poaceae	G	Epz	H	+	–	+
18.	*Chromolaena odorata* (L.) King ex Robinson	Asteraceae	Ph(m)	Pog	H	+	+	+
19.	*Cleome viscosa* L.	Capparaceae	Ch	Bal	H	+	+	+
20.	*Clerodendron inerme* (L.) Gaertn.	Verbenaceae	Ph(m)	Bal	S	–	–	+
21.	*Cochlospermum religiosum* (L.) Alston	Bixaceae	Ph(M)	Pog	T	+	–	–
22.	*Corchorus aestuans* L.	Tiliaceae	Ch	Bal	H	+	–	–
23.	*Crotalaria spectabilis* Roth.	Fabaceae	Ph(m)	Bal	H	–	–	+
24.	*Croton bonplandianum* Baillon	Euphorbiaceae	Ch	Bal	H	+	+	+
25.	*Cyanodon dactylon* (L.) Pers.	Poaceae	G	Ate	H	+	+	+
26.	*Cyperus globosus* All.	Cyperaceae	G	Ate	H	+	–	+
27.	*C. rotundus* L.	Cyperaceae	G	Ate	H	–	–	+
28.	*Dactyloctenium aegyptium* (L.) Beauv.	Poaceae	G	Ate	H	+	–	+
29.	*Dalbergia sissoo* Roxb.	Fabaceae	Ph(M)	Pte	T	–	–	+
30.	*Dentella repens* (L.) Forst.	Rubiaceae	Hc	Ate	H	–	–	+
31.	*Desmodium motorium* (Houtt.) Merr.	Fabaceae	Hc	Bal	H	–	–	+
32.	*Desmodium triflorum* (L.) DC.	Fabaceae	Cr	Bal	H	–	–	+

Table 1 : (*Contd.*)

1	2	3	4	5	6	7	8	9
33.	*Echinochloa colona* (L.) Link.	Poaceae	G	Ate	H	–	–	+
34.	*Eclipta prostrata* (L.) L.	Asteraceae	Hc	Pog	H	–	–	+
35.	*Eragrostis coarctata* Stapf	Poaceae	G	Ate	H	+	+	+
36.	*E. patans* (Retz.) Neer ex Steud.	Poaceae	G	Ate	H	+	–	+
37.	*E. tenella* Roem. & Sch.	Poaceae	G	Ate	H	+	–	+
38.	*Euphorbia heyneana* Spreng.	Euphorbiaceae	Hc	Ate	H	–	–	+
39.	*E. hirta* L.	Euphorbiaceae	Hc	Ate	H	+	+	+
40.	*Evolvulus alsinoides* L.	Convolvulaceae	Hc	Ate	H	+	–	+
41.	*E. nummularius* L.	Convolvulaceae	Hc	Ate	H	+	–	+
42.	*Ficus bengalensis* L.	Moraceae	Ph(M)	Enz	T	–	–	+
43.	*F. religiosa* L.	Moraceae	Ph(M)	Enz	T	+	–	+
44.	*Fimbristylis diphylla* (Retz.) Vahl	Cyperaceae	G	Ate	H	+	–	+
45.	*Bacopa monnieri* (L.) Pennell	Scrophulariaceae	Ch	Ate	H	–	–	+
46.	*Hybanthus ennaespermus* (L.) Muell.	Violaceae	Hc	Spo	H	+	–	–
47.	*Hyptis suaveolens* (L.) Poit.	Lamiaceae	Ch	Bal	H	+	+	+
48.	*Imperata cylindrica* (Linn.) Beauv.	Poaceae	G	Ate	H	–	–	+
49.	*Indigofera enneaphylla* L.	Fabaceae	Ch	Bal	H	–	–	+
50.	*Ipomoea carnea* Jacq.	Convolvulaceae	Ph(m)	Ate	S	+	–	+
51.	*Kyllinga nemoralis* Dandy ex Hutch. & Dalz.	Cyperaceae	G	Ate	H	+	–	+
52.	*Lantana camara* L.	Verbenaceae	Ph(m)	Ate	S	+	+	+
53.	*Leucus aspera* Spreng.	Lamiaceae	Ch	Spo	H	+	–	+
54.	*Ludwigia perennis* L.	Onagraceae	Ch	Ate	H	–	–	+
55.	*Melia composita* Willd.	Meliaceae	Ph(M)	Enz	T	+	–	–
56.	*Merremia emarginata* Hallier, f.	Convolvulaceae	Cr	Ate	Cl	+	–	+
57.	*Ocimum basilicum* L.	Lamiaceae	Ch	Spo	H	+	–	+
58.	*O. sanctum* L.	Lamiaceae	Ch	Spo	H	+	–	+
59.	*Oldenlandia corymbosa* L.	Rubiaceae	Ch	Spo	H	–	–	+
60.	*Parthenium hysterophorus* L.	Asteraceae	Ch	Pog	H	+	+	+
61.	*Peristrophe bicalyculata* Nees	Acanthaceae	Ch	Bal	H	+	–	–
62.	*Polygala chinensis* L.	Polygalaceae	Hc	Spo	H	+	–	–
63.	*Phyllanthus fraternus* Webster	Euphorbiaceae	Ch	Ate	H	+	–	–
64.	*Phyla nodiflora* (Linn.) Greene	Verbenaceae	Hc	Ate	H	–	–	+
65.	*Pilea microphylla* (L.) Liebm.	Urticaceae	Hc	Ate	H	–	–	+
66.	*Pycreus polystachyos* (Rott.) Beauv.	Cyperaceae	G	Ate	H	–	–	+
67.	*Saccharum spontaneum* L.	Poaceae	G	Ate	H	+	–	+
68.	*Scirpus supinus* L.	Cyperaceae	G	Ate	H	–	–	+
69.	*Scoparia dulcis* L.	Scrophulariaceae	Hc	Spo	H	+	+	+

Table 1 : (Contd.)

1	2	3	4	5	6	7	8	9
70.	*Sida cordifolia* L.	Malvaceae	Hc	Spo	H	+	–	+
71.	*S. rhombifolia* L.	Malvaceae	Hc	Spo	H	+	–	–
72.	*Solanum surattense* Burm. f.	Solanaceae	Hc	Ate	H	+	+	+
73.	*Borreria hispida* L.	Rubiaceae	Hc	Spo	H	+	+	+
74.	*Sphaeranthus indicus* L.	Asteraceae	Ch	Pog	H	+	–	–
75.	*Sterculia urens* Roxb.	Sterculiaceae	Ph(M)	Enz	T	+	–	–
76.	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Ch	Bal	H	+	+	+
77.	*Trianthema portulacastrum* L.	Aizoaceae	Hc	Spo	H	–	–	+
78.	*Tridax procumbens* L.	Asteraceae	Hc	Pog	H	+	+	+
79.	*Urena lobata* L.	Malvaceae	Ph(m)	Bal	H	+	–	+
80.	*Vernonia cinerea* (L.) Less.	Asteraceae	Ch	Pog	H	+	–	+
81.	*Xanthium indicum* Koenig	Asteraceae	Ch	Epz	H	+	+	+
82.	*Ziziphus mauritiana* Lamk.	Rhamnaceae	Ph(M)	Bar+Enz	T	+	+	+

Abbreviations :

Life forms : Ph(M) = Megaphanerophyte ; Ph(m) = Microphanerophyte ; Ch = Chamaephyte ; G = Geophyte ; Hc = Hemicryptophyte ; Th = Therophyte ; Cl = Climber.

Diaspore Types : Ate = Atelochore ; Bar = Barochore ; Bal = Ballochore ; Epz = Epizoochore ; Enz = Endozoochore ; Pog = Pogonochore ; Pte = Pterochore ; Spo = Sporochore ; Hyd = Hydrochore.

Habit : H = Herbs ; S = Shrubs ; T = Trees.

Study sites : OB = Overburden dump ; WR = Washery rejects ; AD = Alluvium dump.

Distribution : + = Present ; – = Absent..

by vegetative growth. Slopes with boulders are colonised first by *Chromolaena, Ipomoea, Lantana, Calotropis* and followed by tree saplings of *Adina* and *Sterculia* etc. On the alluvium dump the dominance of *Xanthium* and *Tephrosia* was maintained althrough, while on washery reject dump the dominance of *Hyptis suaveolens* was manifested. The distribution of *Saccharum spontaneum* was noticed along the mine strips and within the overburden dumps as scattered patches.

The relative distribution of different plant families on these dumps is noteworthy (Table 2). Grasses (Poaceae) are represented by 7 and 10 species on the overburden dumps and alluvium dumps respectively. Instead only 1 species of grass was recorded from the washery reject dump site. Legumes are represented by 2, 5 and 3 species respectively on these three above mentioned sites. None of the sedges were noticed on the reject dump. The representation of Asteraceae was higher on the alluvium and washery reject dumps. It was noted that the species of Asteraceae are all C_4 plants.

Table 2 : Distribution pattern of plant families on different waste dumps

Family	No. of species		
	Chasnala		
	Overburden dumps	Washery reject dumps	Alluvium dumps
Aizoaceae	0	0	1
Amaranthaceae	2	3	2
Asteraceae	7	5	7
Cyperaceae	3	0	6
Euphorbiaceae	3	2	3
Fabaceae	2	3	7
Poaceae	7	2	10
Lamiaceae	4	1	4
Rubiaceae	1	1	2
Malvaceae	3	1	2
Acanthaceae	1	0	0
Capparaceae	1	1	1
Verbenaceae	1	1	3

The relative density (RD) and relative frequency (RF) and importance value (IV) of some common plants of coal mine area is given in Table 3. This result indicates the fact that *Hyptis suaveolens* (IV-166.09) is the

Table 3 : Relative density (RD), relative frequency (RF) and importance value (IV) of some common flora of Chasnala Colliery areas, Dhanbad, Bihar

Sl. No.	Plant species	Relative density			Relative frequency			Importance value		
		a	b	c	a	b	c	a	b	c
1.	*Hyptis suaveolens*	80.00	2.50	2.50	60.00	1.38	4.36	166.09	3.88	3.88
2.	*Chromolaena odoratum*	2.50	2.50	30.00	1.38	1.38	10.60	15.06	10.26	99.62
3.	*Tephrosia purpurea*	5.00	25.00	10.00	2.77	50.00	12.76	20.19	101.60	39.15
4.	*Cleome viscosa*	5.00	10.00	15.00	2.77	2.77	6.38	17.09	17.56	36.13
5.	*Xanthium strumarium*	12.50	30.00	2.50	6.38	22.12	8.51	22.61	90.42	15.93
6.	*Lantana camara*	5.00	10.00	5.00	2.77	8.33	6.38	45.04	42.27	16.30

Site a : Washery rejects
Site b : Alluvium dump
Site c : Overburden dump

most important element of the washery reject dump, while *Tephrosia purpurea* (IV-101.60) and *Chromolaena odoratum* (IV-99.62) on alluvium and overburden dumps respectively.

It is also evident from Table 1 that most of the plant species have seeds dispersed by wind (Sporochore, Pterochore, Pogonochore and Cyclochore). These are followed by the Atelechore type i.e., the plants having no special dispersal agents. These features thus indicate the adaptiveness of the flora of this region.

DISCUSSION

Though the dumps sites are nutritionally poor (Mukherjee *et al.*, 1985-87), yet particularly in overburdens and alluvial dumps or in mine strips there is enormous potentiality to acquire natural plant populations from adjoining areas if the sites are not disturbed. The quantity and quality of plant forms on these dumps depend on the available biota in the adjoining areas. The pioneers are ecologically in advantage in their life forms, adaptations etc. on these sites (Seraya and Komov, 1971). The dying and decaying of early forms add to the organic matter and structural changes there and help in the colonisation of late successional forms (Motorina *et al.*, 1971). These sites present no toxicity problem to the acquiring and growth of natural vegetation. Of course the washery reject dump is having comparatively less plant forms and needs amelioration for faster regeneration of plants. This can be done by covering them with some amount of soil after proper levelling. All the study sites have comparatively less legumes, but introduction of some legumes may add to the fertility on these otherwise nutritionally poor substrates. The rocky overburdens exposed after mining for few years, break down rapidly to a structurally excellent neutral soil on which grasses and tropical legumes can be established with only a phosphate fertiliser. Therefore, the observations on the natural flora on the dumps indicate that the dumps can be reclaimed by vegetation growth with native flora where required inputs like fertilisers, water etc. can be kept at a minimum. There is of course the problem of biotic interference, which if taken care of, can sustain the vegetation.

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